THE POWER LINE DISTURBANCE MONITOR: A CASE STUDY OF THE NAVY'S CONTINUING EFFORTS IN THE FIELD OF TECHNOLOGY TRANSFER

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NPS-55Jo75031

NAVAL POSTGRADUATE SCHOOL
Monterey, California

THESIS

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by

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and

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March 1975

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Prepared for Naval Facilities Engineering Command,
Alexandria, Virginia

NAVAL POSTGRADUATE SCHOOL
Monterey, California

The work reported herein was supported by the Naval Facilities Engineering Command.

This report was prepared by:

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER NPS-55Jo75031	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) The Power Line Disturbance Monitor: A Case Study of the Navy's Continuing Efforts in the Field of Technology Transfer		5. TYPE OF REPORT & PERIOD COVERED Master's Thesis; March 1975
		6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) Edward Harry Tempest Lester Arthur VanRooy, Jr.		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS Naval Postgraduate School Monterey, California 93940		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS Naval Postgraduate School Monterey, California 93940		12. REPORT DATE March 1975
		13. NUMBER OF PAGES 28
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)		15. SECURITY CLASS. (of this report) Unclassified
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Technology
Transfer of Technology
Research and Development
Product Development
Research Laboratories
Benefits to Society
Utilization
Power Line Monitor
Electrical Disturbances

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

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DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE
(Page 1) S/N 0102-014-6601

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

(20. ABSTRACT Continued)

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Submitted in partial fulfillment of the
requirements for the degree of

MASTER OF SCIENCE IN MANAGEMENT

from the

NAVAL POSTGRADUATE SCHOOL
March 1975

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This paper presents a case study of the successful attempt of a Navy research laboratory to participate in technology transfer. Background information concerning the Defense Department's research and development budget along with Defense and Navy policy regarding technology transfer is provided. The aggressive technology transfer program devised and implemented by the Navy's Civil Engineering Laboratory is discussed. The development of a power line disturbance monitor and its inclusion into the laboratory's technology transfer program are traced. An assessment of the benefits that accrued to both the public and private sectors of the economy, as a result of this particular project, is made.

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I. INTRODUCTION

Congress has authorized the Department of Defense (DOD) to spend a record $9.3 billion this year on military research, development, test and evaluation (RDT&E) [Ref. 1]. Does this mean that taxpayers are investing <u>only</u> in research for an arms race that may ultimately end in nuclear holocaust?

Not so! In addition to providing for a strong future national defense, a substantial portion of military research and development expenditures are quietly financing new technology that will contribute to the progress of civilian society, perhaps even to its survival. Military advances in areas such as medical research, environmental protection, and air traffic control, just to mention a few, are also products of defense RDT&E spending and deserve equal billing as they are successfully transferred from military to civilian application in order to solve society's mounting problems.

II. CRITICISM LEVIED AT DOD R&D

In recent years, critics have posed questions such as: "Why can't DOD develop a technology utilization program such as NASA did during the peak years of the space program? Look at the spin-off benefits that accrued to all Americans, even the entire world, from that program!"

Criticism of this nature is certainly legitimate and was recognized by the President when he stated,

> As we face the new challenges of the 1970's, we can draw upon a great reservoir of scientific and technological information and skill — the results of the enormous investments which both the Federal Government and private enterprise made in research and development in recent years...we must appreciate that the progress we seek requires a new partnership in science and technology — one which brings together the Federal Government, private enterprise, state and local governments, and our universities and research centers in a coordinated, cooperative effort to serve the national interest... [Ref. 2]

In response to the President's policy statement, several DOD R&D laboratories joined together in July 1971 to form the DOD Technology Transfer Consortium, the purpose of which is "the transfer of existing knowledge, facilities, or capabilities acquired while working on military research and development projects, to the solution of civil problems" [Ref. 3]. Spurred by the knowledge that military research funds expended by DOD can also benefit other segments of our society, the consortium has grown from eleven to thirty-one Army, Navy, and Air Force laboratories [Ref. 4]. In November, 1974, membership was extended to all government laboratories and the Federal Technology Transfer Consortium was formed.

III. THE NAVY'S TECHNOLOGY TRANSFER PROGRAM

The Navy, whose share of the fiscal year 1975 DOD RDT&E budget totaled $3.5 billion, has been a strong advocate of technology transfer for many years. There are thirty-seven

Navy activities involved in research and development throughout the United States, each with a specific research and development mission [Ref. 5]. Because the Navy-Marine Corps team operates in all of the earth's environments – at sea, underwater, and on land – Navy laboratories have been responsible for the development of new and advanced technology in many different areas of engineering and science. The Navy has traditionally been a close partner with university and commercial ocean-oriented research, and has always felt an obligation to share its achievements with these other organizations. Consequently, the Navy was the first military service to issue an implementing instruction calling for an active technology transfer program within the Navy, and requiring the designation of a person as a contact for technology transfer in the various laboratories and components of the Navy under the Navy Material Command. The instruction also calls for an annual report of progress [Ref. 6].

Although technology derived from Navy R&D has been applied successfully to a wide variety of civilian problems since the inception of the technology transfer program, the efforts of one Navy laboratory, in particular, have been an outstanding success. This paper will describe their technology transfer program, and trace the development of one product which is now available commercially and is being used by more than 100 organizations and businesses, both in the public and private sectors, throughout the United States and abroad.

IV. NAVY'S CIVIL ENGINEERING LABORATORY

The Navy's Civil Engineering Laboratory (CEL) located adjacent to the Pacific Ocean in Port Hueneme, California provides a stimulating background for creativity and technological advances. Port Hueneme means "pleasant place" and it is not surprising that the location, just 60 miles west of Los Angeles with its huge industrial complex, attracts the most qualified scientific and technical achievers. The work of the laboratory covers a broad field of technology, going well beyond the scope of civil engineering. The laboratory, operating on an annual budget of $12 million, is the principal RDT&E center for shore and sea-floor activities, and for the support of Navy and Marine Corps construction forces. The laboratory's workload includes programs in electronics, sanitary engineering and mathematics, as well as physics, chemistry and allied sciences.

The staff at CEL numbers approximately 310, more than half of whom are professional engineers and scientists. Master and Doctorate degrees outnumber Bachelor degrees by more than three to one. The laboratory is headed by a military Officer-in-Charge with a solid engineering background and a Technical Director who is a senior Civil Service scientist. The majority of the research personnel are Navy Civil Service employees. A job rotation program that allows the individual to select his own special area of interest, an engineering-in-training program, and rapid advancement are features of the CEL working

environment. The comment of one scientist at CEL is indicative of the feelings of most of the laboratory's employees; "In this age of giant strides in space, the undersea world, in nearly every branch of industry, the challenge is the thing that keeps us alive and awake. Beating the challenge is the thing that gives us real job satisfaction. Without it, life would be pretty dull."

V. TECHNOLOGY TRANSFER AT CEL

CEL has actively promoted technology transfer for many years and is responsible for a host of Navy R&D spin-off items that are benefiting society in the fields of environmental protection and energy conservation. New developments have found their way into the private sector and are stimulating corporate growth in a period when an economic stimulus is most welcome. CEL possesses a wide variety of technical expertise. To further indicate the diversity of ongoing work, the laboratory is involved in the establishment of polar bases on snow and sea ice, deep ocean systems, floating naval bases, waterfront structures, power transient detection and correction, even a skull/brain injury computer program. The success of CEL's technology transfer is attributed to the organization's progressive attitude which is symbolized by the laboratory's motto — "find a way...or make one."

Recognizing the importance of technology transfer, in 1972 the laboratory established a technology transfer program. The

theme of the program centered around the following command statement:

> Implementation of the results of successful work units is perhaps the best measure of the Command's success in fulfilling mission requirements. We must therefore strive at all times for the increased utilization of our research results by the Department of Defense, the Navy, the Navy Facilities Engineering Command, and the entire scientific and technical community. We must also manage the utilization of technology on an objective and systematic basis.

CEL's technology utilization efforts were directed at all appropriate parts of the Navy and addressed its total mission and commitments. The thrust of the program was to close the gap between CEL developed technology and acceptance and application by a wide spectrum of Navy users. It was apparent to CEL that if their created technology was going to sell itself beyond the primary recipient, then a marketing plan was also an essential ingredient. Foremost, the program must be user oriented and involve people in both ends of the spectrum. "CEL is going to push...we must involve the user so he can help pull when we push." The command's formulated technology transfer program contained the following elements:

1. Identify underutilized CEL developed technology.
2. Identify new users and benefits to be gained by them.
3. Select candidates for marketing.
4. Assign internal CEL responsibility by product.
5. Develop background information.
6. Approve/modify marketing strategy.
7. Perform an economic analysis.
8. Develop a marketing plan.
9. Market product (advertise).

10. Evaluate progress.
11. Publicize success or recycle if not successful.

Recognizing the fact that increased utilization of technology was synonymous with increased communication between CEL and potential users, various forms of communication were evaluated and measured for effectiveness in achieving the program's objectives. After finalizing all aspects of the newly developed technology transfer program, CEL's Assistant Officer-in-Charge concluded, "Our utilization efforts are experimental. We really don't know how to promote utilization nor does anyone else. We have some ideas that we'll try and we'll learn in the process. We're talking about promoting change — aggressively promoting change to a better way of doing things."

With the foundation of the program laid, CEL's next step was to choose candidates from newly developed products that were considered to be underutilized but with a high potential for beneficial application within the Navy. The selection included a cathodic protection kit for ship moorings, a weathered paint identification kit, cathodic protection system for water tanks, diver tool kits, a single line heat-traced pipe system, quick camp modules, funicular shell construction, and a three-phase electric power line monitor. The development marketing and impact of the power line monitor on the public and private sectors as a result of CEL's aggressive technology transfer program serves as an example of the total benefits to be gained from Navy research and development.

VI. CEL'S INVESTIGATION OF HIGH QUALITY ELECTRIC POWER

During the latter months of 1963, well before any public concern was expressed over a possible fuel shortage and its resultant effects on electrical power output, CEL initiated a research project to determine the requirements for high quality electric power for sensitive electronic equipment in use at Naval shore stations.

The Navy is a heavy user of electrical power in a variety of shore stations containing technical loads related to command and control, communications, computer and navigation functions in support of the Navy mission. Operational reliability of sensitive equipment constituting technical loads is directly affected by the quality and reliability of power. This power is presently supplied with a wide range of quality and reliability. At the time of the CEL study, few if any satisfactory procedures or techniques existed which would provide for cost effective compatibility between the quality of supplied power and the power requirements of critical, sensitive equipment.

VII. DEVELOPMENT OF POWER LINE MONITOR

During CEL's investigation into the quality and reliability of electrical power at Naval shore stations, it became readily apparent that some means of monitoring and categorizing transient disturbances in power supplies that caused operational malfunctions and damage to critical equipment would be required.

An industry-wide search was conducted to determine if a suitable and economical power line monitor was commercially available. Numerous monitors were found, but most of them were designed to monitor a few specific parameters. Their costs ranged from approximately $300, for a unit that could monitor a single parameter, to elaborate power line monitoring systems costing as much as $25,000 with still only a three parameter capability. There was also the problem of portability. Since many Naval shore installations are located in remote areas, both in the United States and overseas, a several hundred pound monitoring system would not be suitable for shipment to, or use in the field. This led to the CEL development of a prototype, portable, low cost, three-phase power disturbance monitor.

By May 1972, the first prototype monitor had been designed, fabricated, and tested by Mr. M. N. Smith, one of the civilian employees of Civil Engineering Laboratory. It was capable of detecting, categorizing, and counting the occurrences of anomalies in electrical power systems. The monitor could detect power disturbances in all three phases, line-to-neutral voltages without the necessity of differentiating the phase in which the disturbances occurred. It could continuously monitor pulse transients and variations in voltage and frequency which exceeded pre-selected levels. Whenever a pre-selected level had been exceeded, a single count was registered in one of five counters which categorized the disturbances as an under-voltage, an overvoltage, an under/over frequency, a low

magnitude impulse or a high magnitude impulse. Even a combination of disturbances occurring simultaneously could be properly categorized and counted. The monitor contained visual warning lights, an audio alarm, and an AC volt meter [Ref. 7]. The original prototype monitor was housed in a 22 X 14 3/4 X 10 3/4 inch cabinet and weighed only 48 pounds (See figure 1).

The total R&D funds associated directly with the development of the original prototype power line monitor have been estimated at $10,000 [Ref. 8]. The successful completion of this project coincided with the implementation of the laboratory's technology transfer program. After the original prototype monitor had been successfully bench-tested at the Civil Engineering laboratory, the decision was made by the Naval Communications Command to procure six additional monitors for field-testing and utilization at various Navy shore installations. In March 1972, a Request for Proposal to design, fabricate, deliver, and test the six new monitors was submitted to the U. S. Department of Commerce for publication in the "Commerce Business Daily." The successful bidder would be required to meet CEL's specifications for the monitor.

Programmed Power Inc., a small electronics manufacturing subsidiary of Franklin Electric Company, decided to submit a proposal and bid for the contract. The company had recently started operations in Menlo Park, California and had undertaken an extensive research and development project in the field of

uninterruptible power systems. They had also performed some preliminary R&D on power line monitors, with the thought of possibly marketing them in the future. Programmed Power was the successful bidder, and in June 1972, received the contrac for six monitors. The contract called for delivery of the units by September of that year, and for the performance testing to be conducted at the Civil Engineering Laboratory during October. The total amount of the contract was $22,47 or $3,749.50 for each of the six supplied monitors.

VIII. TRANSFERRING THE TECHNOLOGY OF THE MONITOR

While waiting for delivery of the new monitors from Programmed Power, CEL field-tested the original prototype at the Naval Station, Rota, Spain, and the Naval Coastal System Laboratory, Panama City, Florida. Both field evaluations we totally successful. Realizing that the monitor had potentia widespread application for the Navy, CEL issued a complete technical note, describing the monitor and its capabilities in June 1972. The initial distribution of the technical not was to all Naval Facilities Engineering Command activities a the Defense Documentation Center in Washington, D. C.

Based upon the enthusiastic response from the Navy engineering community, CEL made the decision to make the monitor a primary candidate in their technology transfer program. In August, 1972, a press release was sent out offering to make the results of the research and developmen

efforts on the monitor available for use by private industry. The following note appeared in the "Engineering News Letter" section of the September 11, 1972 edition of ELECTRONICS MAGAZINE:

> Power Line Monitor From The Navy
>
> Tired of wondering what your power line is doing, or for that matter, isn't doing? If so, you may be interested in a low-cost, 3-phase power line monitor that keeps an eye on the output of such supplies. The monitor checks for both over and under-voltage and frequency, and positive or negative pulse transients from 50 to 600 volts of pulse duration of from 1 microsecond to 16 milliseconds. The Naval Civil Engineering Laboratory has made the results of this research and development effort available; for further information write: Utilization Officer, L02, Naval Civil Engineering Laboratory, Port Hueneme, Calif. 93403.

The response to that magazine article was overwhelming. Within a week the Civil Engineering Laboratory had received 71 requests for information about the monitor. By the end of March, 1973, the laboratory had received a total of 177 separate information requests from private industry, other military services, governmental agencies, universities, hospitals, 36 state agencies, and 14 different countries.

Meanwhile, Programmed Power Inc. made the decision to develop a monitor suitable for commercial application. The company improved CEL's basic design and introduced their Model 3200 (See figure 2). As could have been predicted, their product was an instant success. Sales for 1973 amounted to $196,000. In 1974 sales of the monitor totaled $454,000 and the 1975 sales forecast predicts close to $1 million.

Programmed Power now offers a complete range of monitors to both the domestic and international markets (See figure 3). The company currently employs fifteen people, six directly as a result of the monitor. By 1978, when Programmed Power expects to enter the uninterruptible power systems market on a fairly large scale, employment is expected to reach 110 people.

IX. BENEFITS DERIVED FROM TRANSFERRED TECHNOLOGY OF THE MONITOR

The economic benefits of CEL's transfer of the monitor technology to Programmed Power Inc. are obvious and the company acknowledges that CEL was responsible for its entry into monitor production [Ref. 9]. Power line monitors have constituted the bulk of the company's business since its formation and is responsible for its growing work force.

The positive impact that CEL's transfer of the monitor technology will have on the country's economy as a whole can also be estimated. Utilizing the economic concept of the multiplier effect, it can be shown that a $10,000 research and development effort by the Navy will have led to the creatio of an estimated $1,650,000 worth of additional goods and services by the end of 1975. If the Navy's R&D expenditure is considered to be the "initial investment," then the resultant "multiplier" will have been 165 — an excellent return by any measure, particularly in these days of economic uncertainty [Ref. 10].

The direct savings to the Federal Government users of the monitor as a result of its being commercially available are significant. The original six power line monitors purchased by the Civil Engineering Laboratory cost $3,749.50 each. The price of the same monitors fell to $2,995 when Programmed Power Inc. went into full-scale commercial production. Since then, the military services and other Federal Agencies have purchased approximately 35 of the monitors. If a conservative cost savings figure of $600 per unit is used, more than twice the initial $10,000 R&D costs have been realized to date.

Although CEL's development of a low cost, versatile power line monitor was initiated to fulfill a Navy need created by varying quality of world-wide electrical power supplies, the current fuel shortage and related energy crisis in the United States have increased industry's demand for power monitoring devices. The power-generating problem with its feared consequences of power outages, brownouts, voltage dips, transients, and frequency variations is worrying industry and rightfully so. According to Mr. Lee Cooper, President of Programmed Power Inc., "Last year's fuel and energy crunch woke up a lot of people in the electronics and computer industries. They found out that much to their dismay, they can no longer take for granted what comes out of that electrical socket in the wall" [Ref. 11].

In a recent article by Mr. C. P. Tsung, a highly qualified expert in electrical power consumption, the author states, "Brownouts will be a fact of life for an indefinite period of time to come." Mr. Tsung further reports that from a recent survey concerning the effects of voltage reductions, it was discovered that during brownouts, poor and unreliable operations were experienced with elevators and their controls, monitoring equipment, escalators, communication equipment, air conditioning equipment, and a wide variety of motors, computers, and other business machines. Particularly sensitive equipment, such as electronic data processing computers, production controls, and medical diagnostic instruments, are affected by even slight voltage variations, and probably should be removed from service when supply voltages do not range within specified requirements [Ref. 12]. Imagine the expense involved when a technician spends hours attempting to debug a computer malfunction when the culprit was not the machine but the power supply; or the consternation of an executive making crucial corporate decisions on computer generated data that may be erroneous; or a doctor's fear that critical medical monitoring instruments may malfunction because of power problems. The monitor can detect and/or indicate solutions for many of these problems.

X. CONCLUSION

The power line monitor is just one example of how Navy R&D efforts combined with an aggressive technology transfer program, such as that at the Navy's Civil Engineering Laboratory, are benefiting society and returning public dividends from defense research dollars.

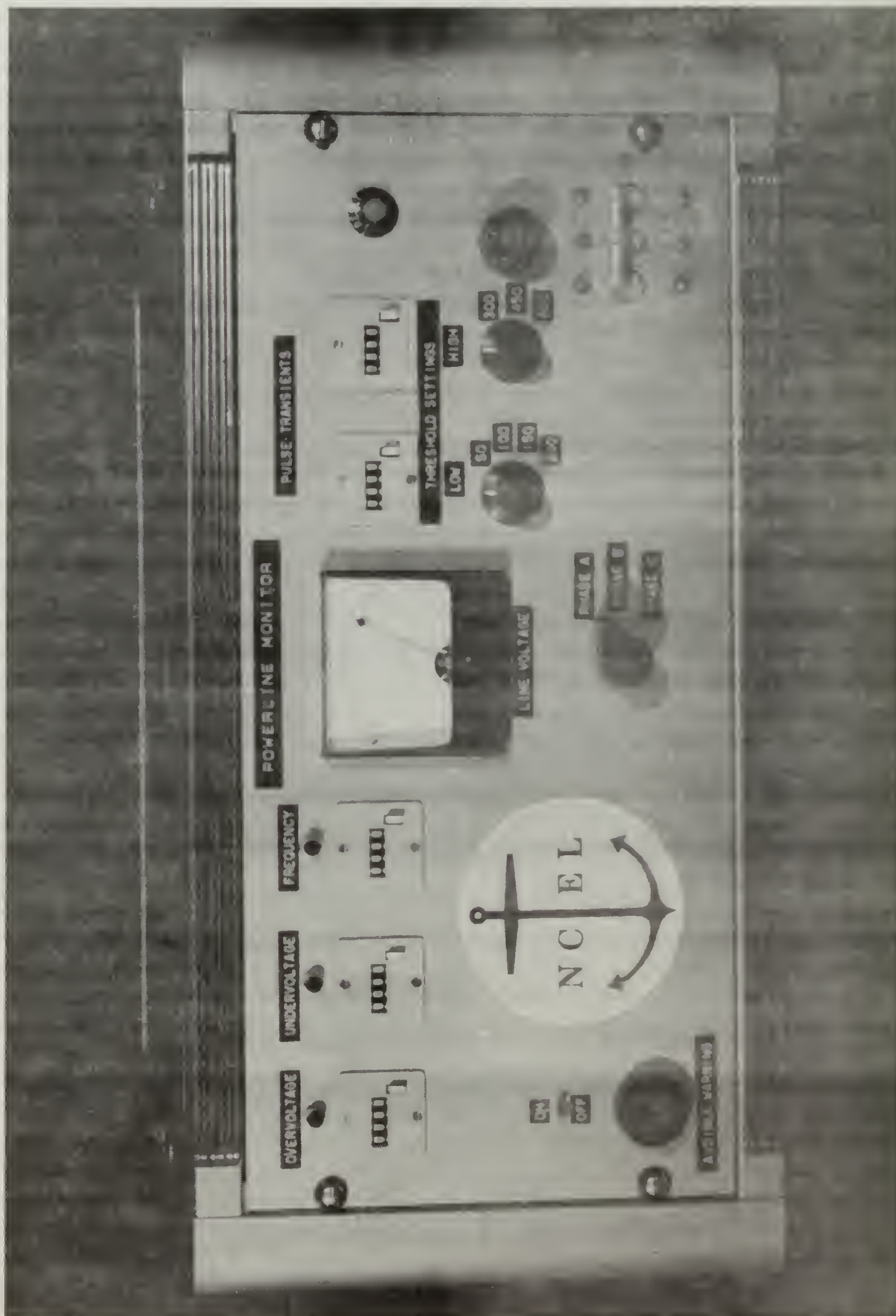
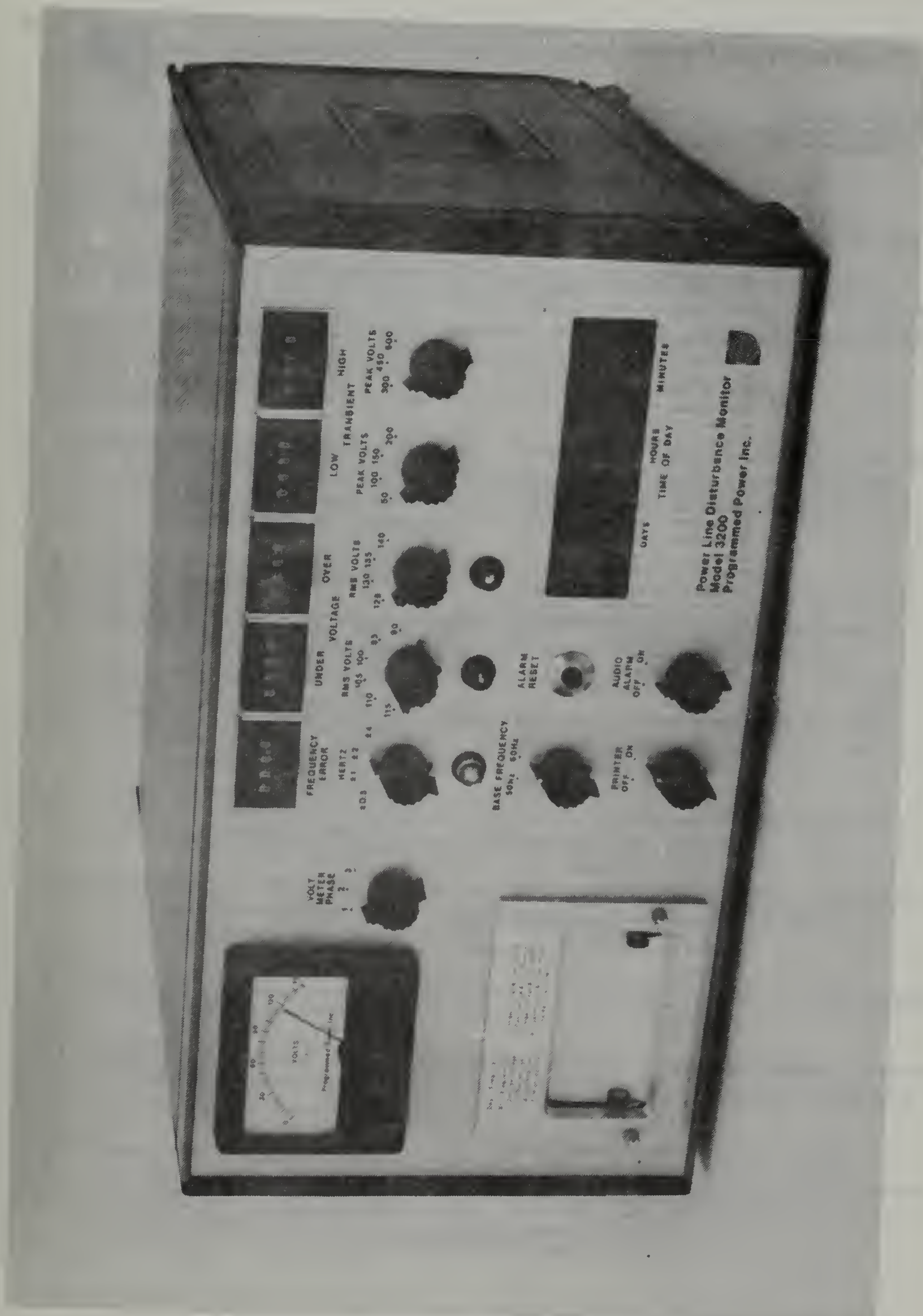

POWERLINE MONITOR
PULSE TRANSIENTS
THRESHOLD SETTINGS
LOW
HIGH
50
100
150
200
400
LINE VOLTAGE
PHASE A
OVERVOLTAGE
UNDERVOLTAGE
FREQUENCY
ON
OFF
NCEL

Figure 1



VOLT METER PHASE
FREQUENCY ERROR
HERTZ
UNDER
VOLTAGE
OVER
LOW
TRANSIENT
HIGH
RMS VOLTS
RMS VOLTS
PEAK VOLTS
PEAK VOLTS
BASE FREQUENCY
ALARM RESET
PRINTER
OFF ON
AUDIO ALARM
OFF ON
DAYS
HOURS
TIME OF DAY
MINUTES
Power Line Disturbance Monitor
Model 3200
Programmed Power Inc.

Figure 2

Figure 3

Programmed Power Inc.

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BIBLIOGRAPHY

1. The Budget of the United States Government, Fiscal Year 1975, U. S. Government Printing Office, Washington, D. C., p. 189.

2. Commanders Digest, U. S. Government Printing Office, Washington, D. C., Vol. 15, No. 18, May 2, 1974, p. 2.

3. Department of Defense Technology Transfer Consortium, Published by the Office of Intergovernmental Science and Research Utilization, National Science Foundation, Washington, D. C. , p. 2.

4. Ibid.

5. Management Analysis Report, Prepared by the Office of the Chief, Research and Development, Department of the Army, for the Director of Defense Research and Engineering, October 2, 1973.

6. Commanders Digest, op cit., p. 3.

7. Smith, M. N., "Three-Phase Power Disturbance Monitor," Technical Note N-1240, Naval Civil Engineering Laboratory, Port Hueneme, California, June 1972, p. 1.

8. "Invention Evaluation Questionnaire," Submitted by the Naval Civil Engineering Laboratory to the Office of Naval Research, August 14, 1972, p. 1.

9. "Low-Priced Line Monitor Spots 0.5 - Microsecond Pulse," Electronics Magazine, November 20, 1972, p. 15.

10. Samuelson, Paul A., "Income Determination: The Multiplier and Fiscal Policy," Economics, McGraw-Hill Book Company, New York, 1967, pp. 222-237.

11. Core, Bernard C., "Power Woes Create a Market," Electronics Magazine, July 25, 1974, p. 81.

12. Tsung, Clarence P., "Operating Electrical Equipment During Brownouts," Reprint from Electrical Construction and Maintenance Magazine, September, 1972.

13. Havelock, Ronald G., Planning for Innovation Through Dissemination and Utilization of Knowledge, Ann Arbor: University of Michigan, Center for Research on Utilization of Scientific Knowledge, 1973.

14. Tripp, Ralph H. and Stotz, John K., Jr., ed., Space Technology Transfer to Community and Industry, Tarzana, California, The American Astronautical Society Publications Office, 1972, 185 pp.

15. Ordway, Frederick I. III, et al., Dividends From Space, New York, Thomas Y. Crowell Company, 1971, 309 pp.

16. Morse, Dean and Warner, Aaron W., ed., Technological Innovations and Society, New York, Columbia University Press, 1966, 214 pp.

17. Jolly, James A., "The Technology Transfer Process: Concepts, Framework and Methodology," Monterey, California, Naval Postgraduate School, 1974, 19 pp. (unpublished).

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